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Taking Odor Mitigation to the Next Level: A Priority for Iowa Agriculture Overview of Projects

Tier 1 Projects

Tier 1 projects have a firm foundation in research and application, but which would further benefit from the statewide application of studies to strengthen the information and suitability for adoption by producers. The technologies include:

- Covers for manure storage (swine, dairy)
- Biofilters (swine)
- Vegetative environmental buffers (swine, layers)
- Diet manipulation
- Siting model to assist producers (swine)

Data will be collected for analysis of odor reduction, specific volatile organic compounds reduction (compounds known to be tied closely to livestock odors), costs and maintenance.

Tier 2 Projects

Swine biofilters

Biofilters are devices using media (such as wet wood chips) that absorb odorous gases, allowing for microbial action to treat odor-causing compounds. Biofilters have been proven to be very effective in mitigating odors, ammonia and hydrogen sulfide. However, the technology only has been tested on a few swine production facilities. The need exists to demonstrate biofilter performance on a wide variety of facility styles and ventilation systems, especially tunnel-ventilated barns. The technology also requires a relatively large footprint to reduce the back-pressure effect on ventilation fans and to allow ample time for odorous gases to be in contact with the biofilter media.

Key Research Questions

- To be effective, the addition of biofilters cannot negatively affect ventilation systems. What are the long-term consequences of using biofilters on animal performance and ventilation fan longevity?
- Can biofilters be installed and used successfully on tunnel-ventilated swine barns? What barn modifications are needed to accommodate biofilters using existing fan systems?
- What is the minimum amount of ventilation air that is biofiltered that yields successful mitigation of odors at mandated separation distances? How can a control system be developed to accommodate this partial mitigation strategy?
- What are the long-term electrical, maintenance and water-use costs of using biofilters?

Vegetative environmental buffers

Vegetative environmental buffers are linear arrangements of live trees and shrubs that have been shown to mitigate odors through a complex of physical and social dynamics. Trees and shrubs

manipulate air movement, helping to intercept, disperse and/or dilute odors. Research suggests that strategic use of the buffers near livestock and poultry facilities can play an important role in mitigating odor in an economically feasible way.

Key Research Questions

- What are the key vegetative environmental buffer design parameters and how can they be managed to enhance benefits and minimize costs?
- How are particulate filtration and mechanical turbulence and vertical mixing of air impacted or enhanced by different tree species and tree/shrub types (e.g. conifer versus deciduous trees); tree location; number of trees or tree rows; tree height;
- What is the optimal porosity (a measure of buffer density) for particulate filtration? For mechanical turbulence?
- VEB positioning (angle) relative to prevailing winds?
- What is the minimum distance of a buffer from vented (mechanically or naturally) buildings to maximize particulate capture and turbulence and minimize potential back pressure and or stagnant air?
- What is the minimum distance that eliminates potential winter snow deposition problems?
- How do the mitigation dynamics vary across animal species, production scale, building types and ventilation systems?
- What are the long-term health impacts on trees that are exposed to conditions near livestock operations? How do stressors, including from ammonia, dust, soil nutrients, desiccation and potential dormancy, affect trees? What species are best suited to such conditions and can still provide mitigation? What management practices may enhance tree survival (e.g., drip irrigation, periodic cleaning of plant surfaces, mulching, etc.)?

Poultry biofilters

Biofilters in swine operations have been shown to be an effective means to significantly reduce odor, particulate matter and gas emissions. Biofilters have not been applied to poultry production systems due to foreseeable problems with rapid plugging of the system with feathers. But biofilters may have the potential to control odors from manure storage facilities on poultry operations using manure-belt systems, which frequently remove manure from laying houses and avoid the issue of feathers.

Key Research Questions

- Following a systematic evaluation of the performance and viability of biofilters for poultry operations, can they be adopted under Iowa animal production conditions?
- What is the efficacy of odor and gaseous emission reduction?
- Are there system limitations due to local climate, housing and ventilation configuration?
- What are the initial investment and operating costs?
- What is the longevity of the system?

Wet scrubbers

Wet scrubber technologies use water to remove odors and gas emissions from ventilation air. Some swine and poultry producers in Germany and the Netherlands are using wet scrubbers. A wet scrubber may have a three-stage (dust-ammonia-odor) or two-stage operation, depending on

the desired results. Performance data under field conditions are relatively limited. The hypothesis is that wet scrubbers may have good potential for odor control in manure storage in manure-belt egg operations as well as tunnel-ventilated swine barns.

Key Research Questions

- Following a systematic evaluation of the performance and viability of wet scrubbers, can they be adopted under Iowa animal production conditions?
- What is the efficacy of odor and gaseous emission reduction?
- Are there system limitations due to local climate, housing and ventilation configuration?
- What are the initial investment and operating costs?
- What is the longevity of the system?

Electrostatic particulate ionization

Electrostatic particulate ionization reduces odor and gas emissions by removing the dust to which odorous compounds adhere. Some research under commercial animal production conditions has shown promise in emissions reduction, but also exposed some practical issues. The manufacturing company continues to address the issues by refining designs. The technology may have the potential for odor control in poultry and swine barns by reducing particulate matter emissions.

Key Research Questions

- Following a systematic evaluation of the performance and viability of electrostatic particulate ionization, can it be adopted under Iowa animal production conditions?
- What is the efficacy of odor and gaseous emission reduction?
- Are there system limitations due to local climate, housing and ventilation configuration?
- What are the initial investment and operating costs?
- What is the longevity of the system?

Biocurtain

Biocurtains reduce odor and gaseous emissions by taking out the dust in the exhaust air to which odorous compounds adhere. Some research under commercial animal production conditions has shown promise, although quantitative data in system performance are lacking. Biocurtains may have potential for odor control in poultry and swine barns by reducing transport of particulate matters beyond the exhaust fans.

Key Research Questions

- Following a systematic evaluation of the performance and viability of biocurtains, can they be adopted under Iowa animal production conditions?
- What is the efficacy of odor and gaseous emission reduction?
- Are there system limitations due to local climate, housing and ventilation configuration?
- What are the initial investment and operating costs?
- What is the longevity of the system?

Topical treatments

Extensive lab-scale studies over the past two years have shown that topical application of certain chemical or mineral agents to poultry manure significantly reduces ammonia and odor emissions.

Appreciable reduction may be possible under field conditions. Research must focus on developing an economically viable mechanical delivery system for application of the treatment agents under certain field conditions (e.g., laying hen manure storage with manure-belt system), and systematic evaluation of the performance of the system under commercial production conditions.

Key Research Questions

- Following a systematic evaluation of the performance and viability of topical treatments, can they be adopted under Iowa animal production conditions?
- What is the efficacy of odor and gaseous emission reduction?
- Are there system limitations due to local climate, housing and ventilation configuration?
- What are the initial investment and operating costs?
- What is the longevity of the system?

Siting model developed for all species

A model has been developed for helping producers make decisions on where to locate new swine production systems. The Community Assessment Model currently is developed for swine only. A need exists to expand the model to include other animal and poultry production systems in Iowa. The key factor needed in the model for development purposes is odor emission data, which includes odor concentration at the source combined with simultaneous ventilation rates at the source.

Key Research Questions

- What odor emission rates are to be expected from high-rise layer barns, belt-house layer barns, turkey finishing barns, beef housing barns and dairy housing barns as affected by season?
- What odor emission rates are to be expected from uncovered and covered poultry litter storage methods by season?
- What odor emission rates are to be expected from beef and dairy feedlot areas by season?
- What odor emission rates are to be expected from contained outside manure storage facilities used in beef and dairy housing operations?
- For all cases listed above, what is the odor concentration measured at 0.25 and 0.50 miles downwind, using an olfactometer, simultaneously measured during source odor emission measurements, by season?

Emerging Technology Projects

Ultraviolet treatment

Ultraviolet treatment uses ultraviolet light to break down odorous compounds. Laboratory research shows that ultraviolet light can be effective in removing livestock odors from moving air. The project would use low-wattage ultraviolet lamps to treat exhaust air from livestock facilities. The project aims to continue testing and optimizing the technology in the laboratory and then begin moving it toward pilot-scale and eventually to the field.

Key Research Questions

- Using low-energy, low-cost ultraviolet treatment, can odor be controlled in a treatment time that is consistent with air turnover rates and environmental conditions (presence of dust and moisture) in the exhaust of facilities?
- In the lab-scale system, how can the ultraviolet treatment be optimized through evaluation of effects of ultraviolet wavelength, treatment time, presence of photocatalysts, presence of dust and moisture, presence of other gases and the economic costs?
- With successful lab-scale evaluation, how can a pilot-scale (1:4 to 1:2 scale wind tunnel) ultraviolet treatment be evaluated and optimized using real livestock and poultry odor and dust and in a treatment time that is consistent with air turnover rates and environmental conditions?
- With successful pilot-scale evaluation, how can a full-scale ultraviolet treatment be installed, evaluated and optimized in an on-farm livestock facility?

Solid-manure injection

A majority of odor complaints are associated with the land application of manure. The injection of liquid manure has been proven to provide excellent odor control during land application. Development of an injection system for solid manure would provide producers with an additional odor control technology during land application.

Key Research Questions

- The first phase of the project would be development and initial evaluation of a pilot-scale prototype. Does an augur or pneumatic injection system approach work best with drier solids (such as turkey litter) and with wetter solids (such as manure from beef feedlots)?
- How does the power requirement to operate a solid manure injection system compare to a liquid manure injection system?
- What level of reduction in odor, ammonia and greenhouse gas emissions can be achieved by injecting solid manure compared to traditional broadcast methods?
- Can a full-scale solid manure injection system prototype be developed that can be easily and competitively built by current equipment manufacturers?

Oil cover on deep pits

The project will evaluate use of a floating oil cover in a deep pit of a swine-finishing facility to reduce odor and gas emissions. Previous research and experience have shown that covering liquid swine manure with a layer of vegetable oil can substantially reduce air emissions.

Key Research Questions

- How can the technology be further evaluated in terms of odor-reduction efficacy, impact on manure nutrient value and cost effectiveness?
- Is using an oil cover indoors more effective than using it outdoors, where it would be subject to influence from the wind? Would indoor use of an oil cover do more to reduce odor and gases from the source?

Topical application delivery

This project will seek to develop a mechanical delivery system for topical application of air emissions mitigation agents. Lab-scale tests have shown that some commercially available

chemical or mineral agents are effective in reducing air emissions (gases and odors) from poultry manure. To extend the application to field situations (e.g., manure storage facility in a manure-belt laying hen operation), a mechanical delivery system is essential. The goal is to develop a mechanical delivery system for field use.

Key Research Questions

- With development of a successful prototype, can this technology evolve from lab-scale to field-scale demonstration?